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Broadband Dielectric Function of Non-equilibrium Warm Dense Gold¹

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Warm Dense Matter refers to states in which the thermal and Fermi energies are comparable and the energy of Coulomb interaction between ions is greater than their kinetic energy. The behavior of such systems is dominated by electron degeneracy, excited electronic states and ion-ion correlations, rendering them a truly daunting many-body problem. Interest in Warm Dense Matter has been growing among broad disciplines including plasma physics, condensed matter physics, Inertial Confinement Fusion science, shock physics and material science under extreme conditions. This is driven by the fundamental urge to understand the convergence between plasma and condensed matter physics, and the practical need to understand dynamic behavior in the transformation of a cold solid into a high energy density plasma. A recent advance in this emerging field is the observation of the broadband optical properties of non-equilibrium warm dense gold at high energy densities. Using the approach of isochoric laser heating in a femtosecond pump-probe experiment we have obtained temporally resolved measurements of the dielectric function in the spectral range of 450-800nm [PRL 96, 255003 (2006)]. This allows us to unveil for the first time the behavior of intraband and interband transitions in warm dense gold at excitation energy densities of $10^6 - 10^7$ J/kg, providing an unique opportunity to examine effects of electron band structure and electron distribution. This talk is a review of the experimental technique and the new findings.

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